

ORIGINAL PAPER

An anatomical study of the thyroid arteries anastomoses

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Abstract

Collateral circles in neck own a particular importance in compensating the symptoms due to the unilateral occlusion of the common carotid artery. In addition, surgical procedures at the level of the thyroid gland and larynx raise the problem of a good knowledge of the arterial morphology at those levels. The present study was designed to investigate the possible morphologies of the thyroid arteries anastomoses. For the present study, 20 human adult specimens were dissected, 15 in cadavers and other five on laryngeal specimens drawn at autopsies. Dissections evidenced bilateral and unilateral anastomoses of the thyroid arteries classified as extra laryngeal and intra laryngeal, the former constantly being represented by the supra isthmic arcade made by the superior thyroid arteries and the retrobar anastomoses of the superior and inferior thyroid arteries. Constant intra laryngeal anastomoses were those of the superior laryngeal artery with the inferior laryngeal artery and, respectively, with the cricothyroid artery. The analogy with the cardiac collateral circulation, the thyroid arteries anastomoses may be classified as intrathyroid and interthyroid arterial anastomoses. We also present in this paper a rare variant that we did not find described in the references we investigated, represented by the paramedian perilaryngeal anastomose of the suprahyoid branch emerged from the lingual artery and the cricothyroid artery sent by the superior thyroid artery. The thyroid arteries supply the collateral circles in neck; the clinicians must be aware of their possible functional value and the surgeons must take into account these arterial morphologies while acting on the neck viscera.

Keywords: thyroid artery, laryngeal artery, cricothyroid artery, lingual artery, elevator *glandulae thyroideae* muscle.

☞ Introduction

The key to increasing safety of thyroid surgery is a thorough understanding of thyroid anatomy and pathology [1]. Collateral circles in neck, as proven for the supraisthmic thyroid arcade, may have a functional value in compensating the symptoms during the occlusion of a single common carotid artery [2, 3]. Collateral pathways of blood flow in the neck are available as support for the anterograde flow through the internal carotid artery on the occluded common carotid artery side. The major blood supply to the thyroid gland comes from two pairs of vessels: the left and right superior thyroid arteries arising from the external carotid artery, that may divide each into an anterior, a posterior and frequently a lateral branch; and the left and right inferior thyroid arteries originating from the subclavian artery, dividing each into a medial and a lateral branch. Collateral vessels from the trachea and esophagus might augment thyroid blood supply [4]. It is known that the superior thyroid artery anastomoses with its fellow by the supraisthmic arcade and with the inferior thyroid artery by retrobar anastomoses [5]. The infraisthmic (subisthmic) arcade unites the inferior thyroid arteries [6]. Also, anastomoses between the right and left cricothyroid arteries were demonstrated [7]. Such arterial anastomoses are involved in surgical procedures that may lead to vascular damage and

bleeding if the anatomical background is not well known. By developing understanding of the anatomy and the ways to prevent each complication, the surgeon can minimize each patient's risk and can handle complications expediently and avoid worse consequence [8].

Recent advances in the use of interventional radiology made out of arterial embolization a possible alternative for the treatment of Graves' disease and other thyroid conditions requiring thyroid ablation. The vascular nature of the thyroid gland dictates the use of extra measures to ensure safety of embolizations by performing selective angiography before the procedure, to be certain of catheter placement [4]. Due to their physiological and surgical importance, we aimed to perform the present anatomical study of the thyroid arteries anastomoses.

Abbreviations

STA – superior thyroid artery; ITA – inferior thyroid artery; SLA – superior laryngeal artery; ILA – inferior laryngeal artery; CTA – cricothyroid artery; LA – lingual artery.

☞ Material and Methods

For the present anatomical study, 20 human adult specimens, 13 women and seven men were used and

dissections performed either directly on formalized cadavers (15 specimens) or on drawn laryngeal pieces (five specimens). The age range of the specimens was 52 years old. Meticulous bilateral dissections of the thyroid arteries and their branches were performed in order to evidence the arterial anastomoses at the level of neck viscera. The anastomoses at the level of the thyroid gland and larynx were carefully dissected, the latter after removing the thyroid cartilage lamina.

☞ Results

In all cases (100%), the supraisthmic arcade was present at the superior border of the thyroid isthmus (Figure 1); in 13 specimens (65%) with the pyramidal lobe present, that arcade was deep to it. That arcade was formed between the anterior branches of the superior thyroid arteries, left and right (bilateral, STA-to-STA anastomosis), except for a specimen (Figure 2), in which the arcade was supplied by the left inferior thyroid artery and the right superior thyroid artery (bilateral STA-to-ITA anastomosis). From that arcade, small branches were sent to the pyramidal lobe when this was present and there were also provided thyroid isthmic branches. One of our specimens presented the elevator glandulae thyroideae muscle and its inferior tendon was traversed by the supraisthmic arcade (Figure 3).

In 14 specimens (70%) the cricothyroid arcade (Figure 3) could be evidenced on the cricothyroid membrane, uniting the left and right cricothyroid arteries (bilateral, CTA-to-CTA anastomosis), no matter the origin of the CTA, either directly from the STA or from the anterior branch of the STA. In seven specimens (35%) a thin infraisthmic arcade was found, uniting the inferior thyroid arteries, left and right (bilateral, ITA-to-ITA anastomosis). In all specimens (100%), on each side, there were found perilobar anastomoses joining the superior and inferior thyroid arteries on that side (unilateral, STA-to-ITA anastomosis); usually these anastomoses were located along the posterior border of the thyroid lobe, intracapsularly (Figure 4) and occasionally intraparenchymally. One specimen (5%) presented an anastomosis on the left side, between the anterior branch of the STA, sending the cricothyroid artery, and the secondary inner branch emerged from the posterior branch of the STA on that side (STA-to-STA unilateral anastomosis) (Figure 5).

Intralaryngeal dissections evidenced in all specimens (100%) the anastomosis (Figure 6) of the superior and inferior laryngeal arteries (unilateral, SLA-to-ILA anastomosis), and also the anastomosis (Figure 7) of the superior laryngeal and cricothyroid arteries (unilateral, SLA-to-CTA anastomosis).

A specimen presented an unusual anastomosis of the lingual and cricothyroid arteries on the left side (Figure 8): the lingual artery sent off the suprahyoid branch, coursing anteriorly and inferiorly over the greater horn of the hyoid bone at the superior border of the thyrohyoid muscle (Figure 9) and descending then over the thyroid cartilage, paramedian, to anastomose with the cricothyroid artery on the cricothyroid membrane.

☞ Discussion

The extralaryngeal anastomoses of the thyroid arteries seem to reflect the dependence of thyroid morphogenesis on the development of adjacent arteries that Alt B *et al.* (2006) evaluated as a mechanism that might have evolved to ensure efficient hormone release into circulation [9]. Thyroidectomy is one of the most frequently performed surgical procedures worldwide. At present, mortality for this procedure approaches 0% and overall complication rate is less than 3%. Nonetheless, major complications of thyroidectomy (i.e. compressive hematoma, recurrent laryngeal nerve palsy and hypoparathyroidism) are still severe complications and account for a significant percentage of medico-legal claims [10]. To avoid bleeding during thyroidectomy, there imposes a good knowledge of the vascular normal and variational anatomy of the gland.

The anastomoses of the thyroid arteries can be summarized as it follows:

- extralaryngeal:
 - the cricothyroid arcade (70%);
 - the supraisthmic arcade (100%);
 - the infraisthmic arcade (35%);
 - the perilobar anastomoses (100%);
 - the CTA-to-STA anastomosis (10%).
- intralaryngeal:
 - the SLA-to-ILA anastomosis (100%);
 - the SLA-to-CTA anastomosis (100%);
 - the SLA-to-SLA anastomosis.

By analogy with the coronary arteries anastomoses, described as intra- and intercoronary, one can also consider intra thyroid and inter thyroid arteries anastomoses:

I. INTRATHYROID ANASTOMOSES: between branches of the same thyroid artery:

- the SLA-to-CTA anastomosis;
- the STA-to-STA anastomosis.

II. INTERTHYROID ANASTOMOSES:

- unilateral, STA-to-ITA:
 - the perilobar anastomoses;
 - the SLA-to-ILA anastomosis.
- bilateral:
 - STA-to-STA:
 - the cricothyroid arcade;
 - the supraisthmic arcade;
 - the SLA-to-SLA anastomosis.
 - ITA-to-ITA:
 - the infraisthmic arcade.
 - STA-to-ITA:
 - the variant supraisthmic arcade.

An occurrence of *M. levator glandulae thyroideae* is reported and its frequency of appearance is established at one in 203 cases (0.49%) [11]. Surgical maneuvers dealing with it, if present, must take into account its inferior tendon relation with the supraisthmic arcade to avoid bleeding.

In the references investigated, we did not find an anastomosis described between the lingual and cricothyroid arteries, ensured by the suprahyoid branch of the lingual artery.



Figure 1 – The cricothyroid arcade (arrows) unites the cricothyroid arteries leaving the right (1) and left (2) superior thyroid arteries; 3 – thyroid isthmus; 4 – supraisthmic arcade; 5 – cricoid cartilage; 6 – thyroid cartilage.

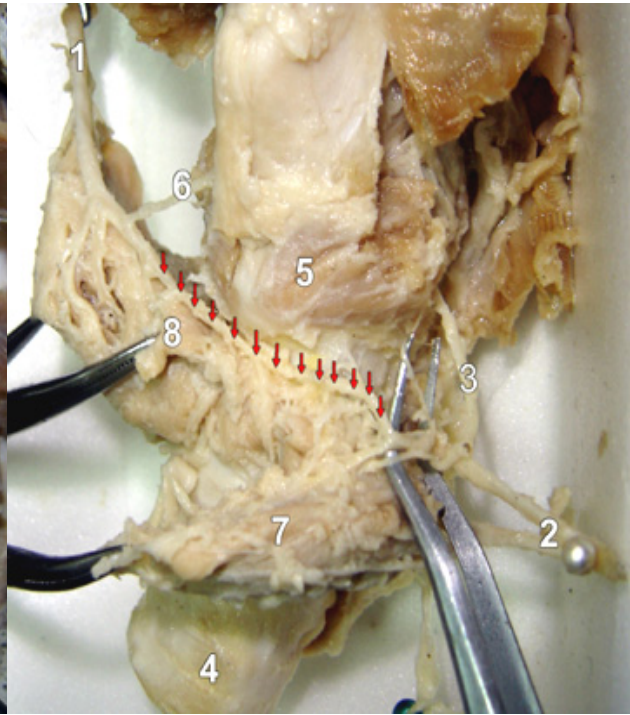


Figure 2 – Right STA to left ITA anastomosis – a variant supraisthmic arcade (arrows): 1 – right superior thyroid artery; 2 – left inferior thyroid artery; 3 – left inferior laryngeal nerve; 4 – trachea; 5 – cricothyroid muscle; 6 – right cricothyroid artery; 7 – left thyroid lobe, reflected; 8 – pyramidal lobe, divided and reflected.



Figure 3 – The supraisthmic arcade through the inferior tendon of the levator glandulae thyroideae muscle (8); 1 – superior thyroid artery; 2 – cricothyroid artery; 3 – left lobe of the thyroid gland; 4 – thyroid isthmus; 5 – thyroid cartilage; 6 – trachea; 7 – anterior jugular vein.

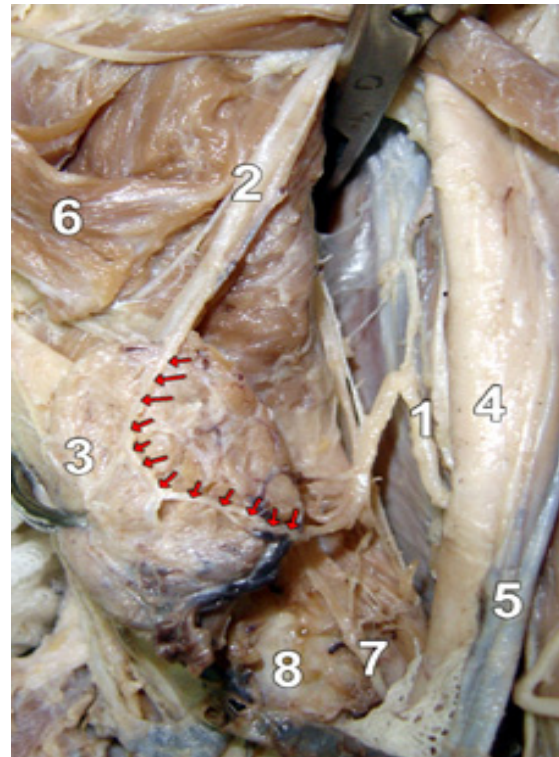


Figure 4 – Left retrolobar anastomosis (arrows) of the inferior (1) and superior (2) thyroid arteries; 3 – thyroid lobe; 4 – common carotid artery; 5 – internal jugular vein; 6 – sternothyroid muscle (reflected); 7 – recurrent laryngeal nerve; 8 – trachea.

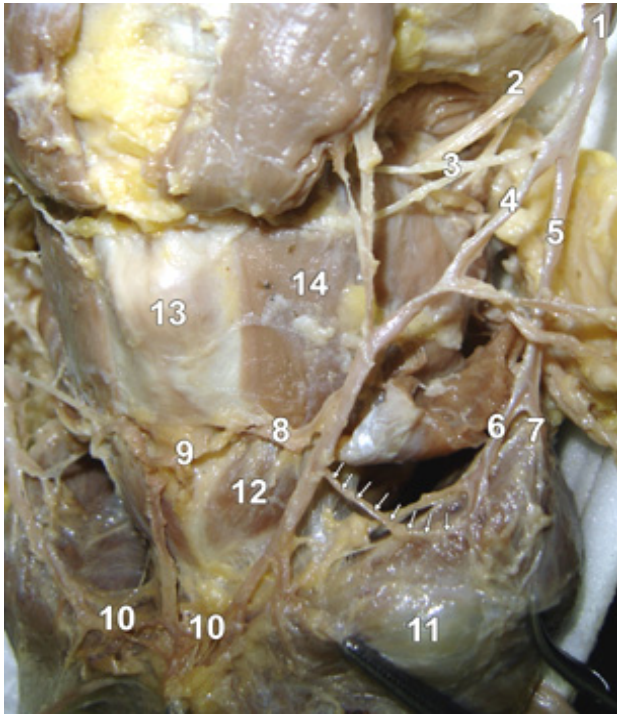


Figure 5 – Perithyroid anastomosis of the left STA branches: 1 – superior thyroid artery; 2 – superior laryngeal artery; 3 – muscular branches; 4 – anterior branch of the STA; 5 – posterior branch of the STA; 6 – secondary inner branch; 7 – secondary outer branch; 8 – cricothyroid artery; 9 – cricothyroid arcade; 10 – supraisthmic arcade; 11 – thyroid cyst; 12 – cricothyroid muscle; 13 – thyroid cartilage; 14 – thyrohyoid muscle.

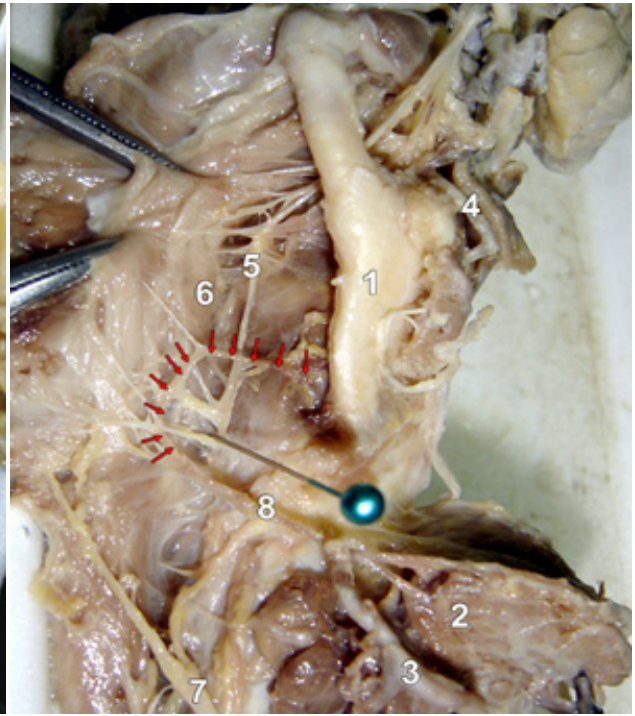


Figure 6 – The anastomosis of the inferior and superior laryngeal arteries (arrows), right side: 1 – thyroid cartilage; 2 – thyroid lobe, reflected; 3 – inferior thyroid artery; 4 – superior laryngeal artery, reflected; 5 – the anastomosis of Galen; 6 – pharyngeal mucosa; 7 – inferior laryngeal nerve; 8 – inferior laryngeal artery.



Figure 7 – The anastomosis (arrows) of the superior laryngeal and cricothyroid arteries, left side, the posterior part of the lamina of the thyroid cartilage was removed to expose the arteries: 1 – superior laryngeal artery; 2 – cricothyroid artery; 3 – thyroid cartilage.

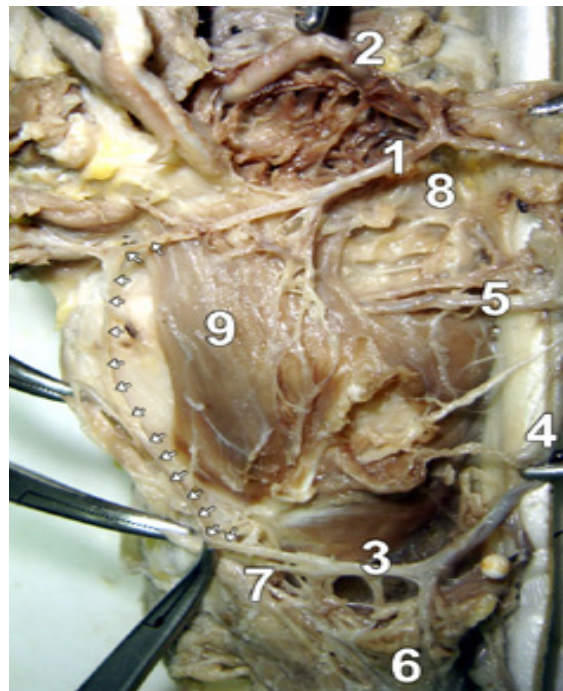


Figure 8 – Perilaryngeal paramedian anastomosis (arrows) between the suprahyoid branch (1) of the left lingual artery (2) and the cricothyroid branch (3) of the superior thyroid artery (4); 5 – superior laryngeal artery; 6 – left lobe of the thyroid gland; 7 – pyramidal lobe; 8 – greater horn of the hyoid bone; 9 – thyrohyoid muscle.

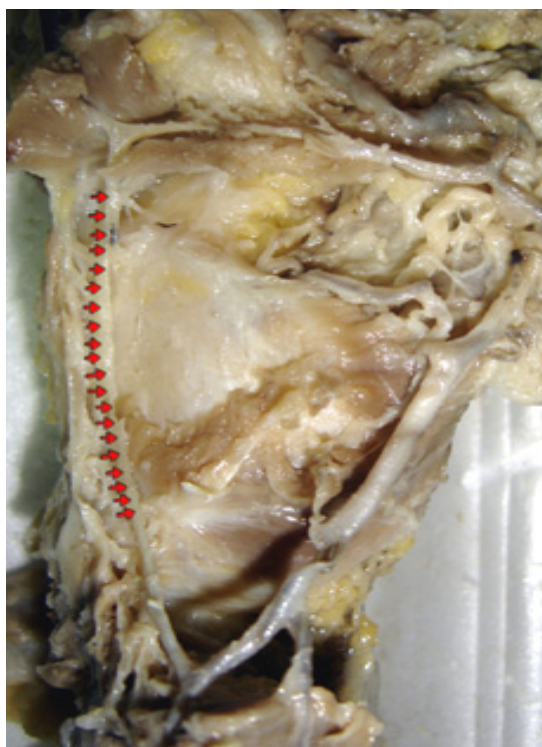


Figure 9 – The anastomosis of the suprahyoid and cricothyroid arteries (arrows) is depicted after the removal of the thyrohyoid muscle.

Such anastomoses, if present, may keep a path of perfusion for the normal cricothyroid artery territory after a thyroid superior pole vascular ligature [12], if the cricothyroid artery emerges distally to the place of the ligature. Also, a thyroid upper pole vascular ligature must be carefully placed, checking whether the superior thyroid artery ramifies or not above the desired place for the ligature; if a high branching site of the superior thyroid artery is present, the ligature risks to leave on place arteries that will represent sources of bleeding if thyroidectomy is further performed. Nevertheless, the cricothyroid artery and its variant anastomoses with the lingual artery must be avoided during cricothyroidotomies and cricothyroidotomies; also, in such situations, the cricothyroid arcade must be considered by surgeons [7, 13]. In addition, we could not evidence the bilateral SLA-to-SLA macroscopic anastomoses, but this may be invariably present at microscopic level, as it results from the description of Anthony JP *et al.* that mention “bilateral perfusion of the entire larynx transplant, including laryngeal and epiglottis mucosa, would occur after revascularization of a single superior thyroid artery” [14].

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Conclusions

The clinical importance of the collateral circles in the neck recommends their protection during neck surgery, if the surgical technique allows this; the clinicians must be aware of their possible functional value and the surgeons must take into account these arterial morphologies while acting on the neck viscera.

References

- [1] BLISS R. D., GAUGER P. G., DELBRIDGE L. W., *Surgeon's approach to the thyroid gland: surgical anatomy and the importance of technique*, World J Surg, 2000, 24(8):891–897.
- [2] MACCHI C., CATINI C., *The anatomy and clinical importance of the collateral circle between the external carotid arteries through an anastomosis between the superior thyroid arteries*, Ital J Anat Embryol, 1993, 98(3):197–205.
- [3] MACCHI C., CATINI C., *Clinical importance of the supra-isthmus anastomosis between the superior thyroid arteries in six cases of occlusion of the common carotid artery*, Surg Radiol Anat, 1995, 17(1):65–69.
- [4] XIAO H., ZHUANG W., WANG S., YU B., CHEN G., ZHOU M., WONG N. C., *Arterial embolization: a novel approach to thyroid ablative therapy for Graves' disease*, J Clin Endocrinol Metab, 2002, 87(8):3583–3589.
- [5] WILLIAMS P. I., BANNISTER L. H., BERRY M. M., COLLINS P., DYSON M., DUSSEK J. E., FERGUSON M. W. J. (eds), *Gray's Anatomy*, 38th edition, Churchill Livingstone, New York, 1995.
- [6] PATURET G., *Traité d'anatomie humaine. Tome III, fascicule I. Appareil circulatoire*, Masson & C^{ie}, Editeurs, Paris, 1958.
- [7] DOVER K., HOWDIESHELL T. R., COLBORN G. L., *The dimensions and vascular anatomy of the cricothyroid membrane: relevance to emergent surgical airway access*, Clin Anat, 1996, 9(5):291–295.
- [8] SCIUMÉ C., GERACI G., PISELLO F., FACELLA T., LI VOLSI F., LICATA A., MODICA G., *Complications in thyroid surgery: symptomatic post-operative hypoparathyroidism incidence, surgical technique, and treatment*, Ann Ital Chir, 2006, 77(2):115–122.
- [9] ALT B., ELSALINI O. A., SCHRUMPF P., HAUF S., LAWSON N. D., SCHWABE G. C., MUNDLOS S., GRÜTERS A., KRUDE H., ROHR K. B., *Arteries define the position of the thyroid gland during its developmental relocation*, Development, 2006, 133(19):3797–3804.
- [10] LOMBARDI C. P., RAFFAELLI M., DE CREA C., TRAINI E., ORAGANO L., SOLLAZZI L., BELLANTONE R., *Complications in thyroid surgery*, Minerva Chir, 2007, 62(5):395–408.
- [11] LEHR R. P. JR., *Musculus levator glandulae thyroideae: an observation*, Anat Anz, 1979, 146(5):494–496.
- [12] SKANDALAKIS J. E., SKANDALAKIS P. N., SKANDALAKIS L. J. (eds), *Surgical anatomy and technique – a pocket manual*, 2nd edition, Springer Verlag, New York, 1998.
- [13] BOON J. M., ABRAHAMS P. H., MEIRING J. H., WELCH T., *Cricothyroidotomy: a clinical anatomy review*, Clin Anat, 2004, 17(6):478–486.
- [14] ANTHONY J. P., ARGENTA P., TRABULSY P. P., LIN R. Y., MATHES S. J., *The arterial anatomy of larynx transplantation: microsurgical revascularization of the larynx*, Clin Anat, 1996, 9(3):155–159.